ChE 317: INTRODUCTION TO CHEMICAL ENGINEERING ANALYSIS
T. Th 8-9:30
CPE 2.218

Personnel Contact Information

Course Instructor:
Prof. Lynn Loo
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Teaching Assistant:
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Textbook

"Basic Principles and Calculations in Chemical Engineering" by D.M. Himmelblau and J.B. Riggs, 7th Ed., Prentice Hall.

Lectures

T, Th 8:00-9:30 in CPE 2.218
Please be punctual. Attendance is mandatory (see quizzes below).

Recitation

#13215 T 2:00-3:00 in CPE 2.206
#13220 W 3:00-4:00 in CPE 2.212

Mailing List

A mailing list is set up to facilitate discussion amongst students, the TA, and myself for ChE 317. You are automatically subscribed to the mailing list if you are registered for this class. Use the mailing list to post ChE 317-related questions. The mailing list address is che317-ll@che.utexas.edu.

Email

The best way to research your TA and I outside of lecture and office hours is email.

Course Website

A course website has been set up – this is where I will be posting lecture notes, problem sets, solutions to examples, etc. Be sure to check this site regularly for updates and print your lecture notes prior to coming to class. The website address is: www.che.utexas.edu/lloo/che317_s05.htm.

Course Syllabus

I. Introduction to Engineering Analysis

- What is chemical engineering?
- Problem definition and "how to get started" on a general problem
- Dimensions, units and conversions
- Process and process variables
- Chemical compositions, temperature, and pressure measurements; manometer applications
- Chemical reaction terminology and applications: stoichiometry, limiting reactant, % excess reactant, degree of conversion

II. Materials Balances

- Basic types: mass, elemental and chemical components
- Single unit: reactive and non-reactive
- Multi-unit non-reactive processes: bypass, recycle, and purge
- Multi-unit processes with reactions: bypass, recycle, and purge

III. Property of Materials

- Ideal gases: pure and mixed; with applications to material balances
- Real gases: pure and mixed; with applications to material balances (focus on *z* factors but introduce equations of state, and trial-and-error solutions)
- Vapor pressure: Antoine and Clausius-Clapeyron equations; Cox charts and steam tables
- Gas-vapor mixtures: relative saturation, relative humidity, dew point temperature, dew point pressure, condensation, saturation and drying problems
- Vapor-liquid equilibrium: Raoult's Law

IV. Energy Calculations

- Calculations of potential, internal, kinetic and enthalpy changes; using polynomial C_p, phase changes, thermodynamic charts, etc.
- Non-reactive energy balances: open steady-state turbines, heat exchangers, throttle valves, and filling and emptying of vessels
- Reactive energy balances: mostly open steady-state systems, including multiple reactions with arbitrary feed and conversions and temperatures
- Steady-state mechanical energy balance with Bernoulli's equation

Grading

Students may select one of two grading schemes [choice should be indicated in writing on the last day of class]

	Scheme A	Scheme B
Homework	10	10
Quizzes	20	15
Tests	70	50
Final Exam	0	25

Study group: Students will form study groups of three. The mission of the study group is to provide a formal forum for students to work together, learn and teach each other. I will reserve the right to change the composition of the study groups during the semester.

Homework: Homework will be assigned at the end of the lecture period; they are due at the beginning specified lecture period (usually a week from assigned date). Late homework will not be accepted. Homework must be handed in individually, but you are encouraged to work with members of your study group.

Reading Assignments: At the end of each lecture, you will also be given a reading assignment. Read the sections prior to the next lecture. Work the example problems and use the *Key Ideas, Key Words, Self Assessment Test, Thought Problems, and Discussion Questions* in your textbook as a guide to whether you have fully understood the material.

Quizzes: There will be five quizzes of one or two questions held during the lecture period. These quizzes are based on materials covered in reading assignments, classroom discussions, and homework. A bonus of 5 points will be added to your final grade if you score perfect tens on all your quizzes. You have one week after the quiz is returned to you to request for re-grading. Re-grading requests should be submitted in writing at the end of the lecture period.

Tests: Three tests are scheduled for 7:00-10:00 pm on February 22, March 29, and May 3 in CPE 2.220. If all the members of a study group scores above a 90 on their tests, a bonus of 5 points will be added to your final grade. You have one week after the test is returned to you to request for re-grading. Re-grading requests should be submitted in writing at the end of the lecture period.

Course Goals and Objectives

To introduce students to the principles and calculation techniques used in the field of Chemical Engineering, specifically:

- To acquaint students with the fundamentals of material and energy balances as applied to chemical engineering
- To acquaint students with efficient methods of and life-long skills for problem solving
- To offer practice in defining problems, collecting data, analyzing data
- To help a student decide if he or she has chosen the right field

Knowledge, Abilities, and Skills Students Should Have Before Entering the Course

- One year of freshman mathematics (algebra, solutions of simultaneous equations, quadratic equations, basic differentiation and integration, trigonometry and basic geometry [areas and volumes of simple shapes]) – *M408C, M408D*
- Chemistry (stoichiometry, concept of mole, molecular weight, concentration, molarity, molality, etc.; enthalpy of reaction, ideal gas law, pressure, absolute temperature) – *Ch302, Ch204*
- Basic knowledge of statics and dynamics in physics (concepts of force, work, pressure, kinetic energy, potential energy) – *Phys303* or high school physics
- Spreadsheet calculations for solving systems of linear equations, function minimization, and plotting – *ChE210*
- Time management skills

Knowledge, Abilities, and Skills Students Should Gain From this Course

- Familiarity with chemical process equipment
- Exposure to systems analysis and concepts of unit operations
- Ability to convert between different sets of units, to use the appropriate gravitational conversion factor, and to distinguish between gauge and absolute pressures
- Ability to write and balance chemical reaction equations
- Ability to identify the excess and limiting reagents, and calculate the percent conversion and yield of reactions
- Ability to define steady state and distinguish between open and closed systems
- Ability to solve material balances for systems with or without a chemical reaction; ability to solve a number of interconnected units involving recycle, bypass, and purge
- Ability to define an ideal gas, and calculate based on the perfect gas equation
- Ability to apply Dalton's and Amagat's Laws for ideal gas mixtures
- Ability to apply equations of state (e.g., van der Waals equation) for real gas calculations and to define conditions for using equations of state
- Familiarity with non-ideal gaseous mixtures; ability to predict P-V-T behavior using equations of state and compressibility factors

- Ability to define vapor pressure, saturation, equilibrium, triple point, dew point, partial saturation (humidity), etc.; ability to distinguish between wet and dry bulb temperatures
- Ability to apply Raoult's and Henry's Laws for multicomponent systems
- Ability to apply the phase rule
- Ability to define heat, work, energy, enthalpy, etc.
- Ability to estimate heat capacities and calculate enthalpy changes, with and without phase changes
- Ability to use steam tables
- Ability to solve energy balances for open and closed systems, with or without chemical reactions
- Ability to solve simple combined material and energy balances (with or without chemical reactions)
- Ability to distinguish and calculate adiabatic and non-adiabatic problems
- Ability to apply spreadsheet calculations to mass and energy balance problems
- Exposure to library and reference data sources
- Ability to work in groups

<u>Chemical Engineering Program Outcomes Achieved</u>

Program Outcomes are a list of knowledge, skills, and abilities every Chemical Engineering student should have at the time of graduation. The Chemical Engineering Department at the University of Texas at Austin has defined six such outcomes (as listed on the departmental website):

1. An ability to apply knowledge of mathematics, chemistry, physics, biology, computing, safety, and engineering.
2. An ability to design, conduct, analyze, interpret, and report on experiments relevant to chemical engineering practice.
3. An ability to use the techniques, skills, and modern engineering tools necessary for the practice of chemical engineering.
4. An ability to apply and integrate the major elements of chemical engineering to solve problems of analysis, design, optimization, and control of components, systems, and processes important in chemical engineering practice.
5. An ability to participate effectively in team-oriented activities, including open-ended projects that foster an appreciation for leadership, lifelong learning, professional and ethical practice, and the societal and global impact of engineering solutions.
6. An ability to communicate effectively in oral, written and graphical forms.

ChE 317 contributes to building four of the six outcomes. Although we do not cover every detail in each of the four outcomes, we do address some key points. Specifically:

1. Students will *apply knowledge of mathematics, chemistry, physics, and computing*

2. Students will *apply and integrate the major elements of chemical engineering to solve problems of analysis*
3. Students will *participate effectively in team-oriented activities*
4. Students will learn to *communicate effectively in written form*

Impact on Subsequent Courses in Curriculum

Virtually every subsequent ChE course requires material and energy balance concepts. Additionally, properties of materials (gas laws, vapor pressures, etc.) are important in *Ch322, ChE322, ChE354, ChE350, ChE 363, and ChE473K.*

Academic Integrity

The University has a strict policy on academic integrity. Any form of plagiarism or academic dishonesty will NOT be tolerated in ChE 317. If you have any questions, please consult the websites below:

http://www.utexas.edu/depts/dos/sjs/academicintegrity.html
http://www.utexas.edu/courses/clubmed/plgrism_cit.html

Failure to comply with the University's policy will result in a "zero" in the assignment and an "F" for ChE 317.